



ELSEVIER

Cognitive Development 16 (2001) 595–615

---

---

COGNITIVE  
DEVELOPMENT

---

---

# Children's difficulties with partial representations in ambiguous messages and referentially opaque contexts

E.J. Robinson<sup>a,b,\*</sup>, I.A. Apperly<sup>b</sup>

<sup>a</sup>*The Department of Psychology, Keele University, Keele, Staffordshire, ST5 5BG, UK*

<sup>b</sup>*School of Psychology, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK*

Received 1 June 1999; accepted 1 October 2000

---

## Abstract

In two experiments, 4–6-year-olds' performance in a communication game with ambiguous messages was compared with their handling of a puppet character's partial knowledge. In the partial knowledge tasks the puppet was partially informed about an object in a box: e.g., he knew it was a ball but not that it was a present. Children, who acknowledged that he did not know the ball was a present, often judged incorrectly that he knew there was a present in the box. That is, they neglected to treat the referring expression as substitution-sensitive. In the communication game, matching questions about what the speaker said showed the same pattern of errors. Correct evaluation of message ambiguity was significantly related to the more difficult, substitution-sensitive questions both about what was said and about what the puppet knew. Failure to identify ambiguity in utterances did not arise from general confusion of words spoken with intended meaning, since children correctly rejected some true descriptions of the intended referent as having been said. Rather, children failed to hold partial representations under the particular terms of their description. © 2001 Elsevier Science Inc. All rights reserved.

*Keywords:* Theory of mind; Referential opacity; Partial knowledge; Ambiguity

---

---

\* Corresponding author. The Department of Psychology, Keele University, Keele, Staffordshire, ST5 5BG, UK.

*E-mail address:* e.j.robinson@bham.ac.uk (E.J. Robinson).

## 1. Introduction

Two recent studies suggest a split in children's basic mentalising ability with understanding the implications of partial knowledge being significantly harder than understanding false belief (Apperly & Robinson, 1998, in press). In the current paper these findings are used to pose novel questions about children's understanding of referential communication. We propose that evaluating ambiguity in messages, which is also more difficult than acknowledging false beliefs, turns on the same ability as understanding partial knowledge.

Studies by Apperly and Robinson (1998, in press) and Russell (1987) into children's handling of mentalistic referential problems investigated children's handling of the way in which a verbal description (or other representation) of a person's mental state is constrained by what that person knows. In Apperly and Robinson's simplified version of Russell's task we used objects referred to by two descriptions (such as a ball that was a present). The children (aged 4 and 5 years) and the experimenter knew both descriptions whilst the puppet protagonist (Heinz) saw that it was a ball, but was not told that it was a present. Children's handling of the puppet's partial knowledge was tested with two kinds of question involving propositional attitude reports. In one, "Does Heinz know the ball is a present?" (correct answer no), the overall meaning was insensitive to the form of the referring expression "ball": Any other true description of the object (which the child participant understood) could be substituted for "ball" and the answer to the question would remain the same. We label this question substitution-insensitive. In so far as this question tested whether children could acknowledge that the puppet had a mental state that was independent of their own, it posed a similar problem to the standard tests of children's handling of false beliefs (e.g., Gopnik & Astington, 1988; Wimmer & Perner 1983), and was indeed similar in difficulty (Apperly & Robinson, 1998).

The second question was "Does Heinz know there's a present in the box?" (adults answered "No"). By contrast with the first, the referring expression "present" served the dual role of referring to and of describing Heinz's knowledge. Because of this it is not possible to substitute other extensionally true descriptions freely: For example, "rubber sphere" would alter the meaning of the question. Such contexts are known as intensional or referentially opaque (see e.g., Searle, 1983). In order to highlight the contrast between this and the other apparently similar question about Heinz's knowledge, we label this the substitution-sensitive question.

Answers to the two questions about Heinz's knowledge of the ball-present were in line with Russell's (1987) results using different materials: Many children who denied that Heinz knew that the ball was a present (in answer to the substitution-insensitive question) nevertheless asserted that he did know there was a present in the box (in answer to the substitution-sensitive question).

A possible interpretation of this result is that it is the easier, substitution-insensitive, question that reflects children's competence at handling partial knowledge. Children's relative difficulty with the substitution-sensitive question might be attributed to performance factors such as extra linguistic/pragmatic demands (see Russell, 1996 for such an interpretation). Importantly, results from a second experiment were inconsistent with this suggestion. Children who answered correctly the substitution-insensitive question nevertheless failed to predict accurately the puppet's actions on the basis of the very same partial knowledge assessed by that question. This time the ball was also, unknown to Heinz, a bell. The ball–bell was placed in one location, and Heinz knew that a typical bell was in a different location. Later Heinz wanted to make a noise and children predicted where he would go. It was correct to predict that he would go to the typical bell. Children who correctly judged that Heinz did not know the ball was a bell (a substitution-insensitive question), were nevertheless equally likely to predict that Heinz would go to either of the two locations to make a noise. These children nevertheless made correct predictions in a control task in which Heinz was completely, rather than partially, ignorant of one of two pencil sharpeners in two different locations.

These results suggested that success on the easier substitution-insensitive question could give a misleading impression of mastery of the implications of partial knowledge. They further suggested that children's problems with the substitution-sensitive (referentially opaque) questions were not merely with the linguistic or pragmatic conventions that govern their meaning, since predicting that Heinz would search as if fully informed was clearly wrong, and not just an unconventional interpretation. The results with the control task also highlighted the difference in difficulty between the case of *total* ignorance of a state of affairs (as also assessed in the standard false belief tasks) and the case of *partial* ignorance.

These findings led us to the conclusion (Apperly, 1999; Apperly & Robinson, 1998) that in an important sense children failed to represent Heinz's knowledge as partial and thus held under some descriptions and not others. Their treatment of what it is to know something is qualitatively different from an adult's. This conclusion accommodates children's apparently self-contradictory pattern of success and failure on the substitution-insensitive and substitution-sensitive questions because failing to hold a representational expression as partial means that they will give primacy to its referential function, which in contrast to an adult reading, exceeds its descriptive significance. The substitution-sensitive question, unlike the substitution-insensitive one, reveals this problem because it is sensitive to the particular terms used to secure reference to Heinz's knowledge. In contrast, it is possible for children to handle the substitution-insensitive question, where meaning is insensitive to the particular referential term, in such a way that their failure to hold representational content as partial is not exposed.

The question we now pose is whether these findings about children's handling of mental representations can offer insights into their handling of linguistic ambiguity.

Numerous investigations over the last 20 years provide consistent evidence of age-related changes in children's handling of ambiguous utterances. When confronted with utterances that are intended to refer to a single object or event in the world, but which actually refer to more than one, young children readily make a single interpretation, possibly for the simple reason that they fail to notice the multiple reference. Later, they show signs of being unsure and may even acknowledge uncertainty about what the speaker meant, but having made an interpretation they seem to lose track of the problem and are confident that their interpretation is the correct one. Later still, typically at around the age of 7 years, children are able to identify the message itself as the source of the problem and realise that further information is necessary to guarantee that the listener will make the correct interpretation (e.g., Beal & Flavell, 1982; Flavell, Speer, Green, & August, 1981; Robinson, 1994; Robinson & Robinson, 1977, 1983; Robinson & Whittaker, 1985, 1987).

Accounts of children's problems with utterance ambiguity often claim that children fail to treat the utterance as a clue to intended meaning, and more particularly fail to hold in mind the distinction between a speaker's intended meaning or intended referent and the literal meaning of the words themselves (Beal, 1988; Bonitatibus, 1988; Robinson, Goelman, & Olson, 1983; Robinson & Robinson, 1977; Robinson & Whittaker, 1986, 1987). Evidence consistent with this characterisation comes from Robinson et al. (1983). Children played two variations of a communication game with the experimenter. In both variations, child and experimenter sat on either side of an opaque screen with identical sets of pictures, each took turns to tell the other about one of the set, and then listener and speaker compared their choices to see whether the listener had selected the correct picture. On some trials the experimenter gave an utterance that referred to two of the pictures, and the child saw that she/he had chosen wrongly. In the first version of the game, following these trials the child was asked "Did I tell you enough about my card?" and if she/he judged "No," "What should I have said?" In the second version of the game the experimenter offered the child the suggestion that she had given a disambiguated version of the message, e.g., "A man with a blue flower, is that what I said?" when the message had actually not specified the flower's colour. For both games there were parallel trials in which the child was speaker and the experimenter was listener, and children's answers to the test questions were unaffected by the role played. The results showed a highly significant relationship between performance in the two variations of the game: 5- and 6-year-olds who failed to identify ambiguous utterances as inadequate, were inclined also to accept the suggestion that a disambiguated version of the utterance had actually been said. Importantly, they did not accept just any suggestion; they correctly rejected suggested messages that did not match the intended referent,

such as "... a man with a red flower...?" The conclusion drawn from these studies was that once these children knew what the speaker meant, they were unable to hold separately in mind the ambiguous verbal description. Bonitibus (1988) reports similar results. This account may provide a way of describing children's behaviour with ambiguous utterances, but is not particularly clear about what the change at 6–7 years really consists in. By bringing our earlier analysis of children's problems with partial mental representations to bear on their handling of ambiguous linguistic representations we hope to make a move in this direction.

Of course all representations only capture a subset of the features of their referents. Much of the time we can ignore this without any problems arising, and in this paper we have been using "partial knowledge" and "partial representation" to refer to representations whose partial nature is relevant in a particular situation. Heinz's mental representation of the ball–bell did not include the fact that it was a bell, and this was clearly relevant to his search for something with which to make a noise. Similarly, when an ambiguous utterance fails to specify features that allow the listener to differentiate the intended referent from other potential referents, it is clearly important that the linguistic representation of the referent is only partial. For example, (anticipating Experiment 1) imagine a pair of balloons, one red and round, one red and long, and an experimenter's referential utterance "I've chosen one, and it's a red balloon." This is ambiguous because the speaker actually wanted to identify the round balloon. Identifying the ambiguity in the message as the source of the problem (as opposed to merely recognising that, as listener, one has a problem identifying the intended referent) requires that the message contents be held under their particular terms of description; held not just as referring but as doing so in a particular way.

A further consequence of the fact that messages specify their referents only partially is that, in common with mental states, messages can give rise to opaque (substitution-sensitive) contexts when they themselves are represented. This is illustrated by the fact that referential terms in reported utterances may resist substitution of coreferential terms. Continuing from the example described above, a direct report of the experimenter's message "He said that he chose the red balloon" is sensitive to the particular form of the referring expression "red balloon."<sup>1</sup> Although we may know that the balloon to which the experimenter referred was round, it would be incorrect to report that the experimenter "...said that he chose the round balloon" since the experimenter said "red balloon" not "round balloon." The answer to the question "Did he say that it was the round balloon that he chose?" is thus "No." The reason for this is analogous to the reason for a negative answer to "Does Heinz know that there's a present in the box?" in Apperly and Robinson's (1998) experiment. Both cases involve an

---

<sup>1</sup> For our purposes we will only be concerned with direct quotation.

intensional context that arises because representations only partially capture their referents. In the former, coreferential substitution is sensitive to the particular form of the referring expression of the original utterance; in the latter it is sensitive to the limited knowledge of Heinz.

There is already some evidence in the literature of a link between children's handling of ambiguity and questions about utterances that are sensitive to the form of referential terms. Recall that Robinson et al. (1983) asked children "The man with the blue flower' is that what I said?" (when the actual utterance was "...the man with the flower") and found that such questions were as hard as, and strongly related to children's ability to evaluate message ambiguity. As described earlier, these authors concluded that children's problems with message ambiguity were due to an inability to retain the particular, under-specified meaning of the message once they knew the interpretation intended by the speaker. However, this conclusion is called into question by Apperly and Robinson's (1998) finding that, when asked about partial knowledge, a reformulated question that was not sensitive to the particular referential terms employed (substitution-insensitive question) was easier for children to answer correctly than a substitution-sensitive question. For if linguistic and mental intensional contexts are developmentally as well as formally related, we would expect children to succeed in answering a substitution-insensitive question about what was said before they can evaluate message ambiguity. If this is the case then children's problems with ambiguity cannot be due to problems distinguishing message meaning from intended meaning, at least not in the way supposed by Robinson et al. (1983) and Robinson and Whittaker (1987). According to those accounts, children who fail to evaluate ambiguous messages as such should accept *any* true description of the intended referent as having been said (Robinson & Whittaker, 1987).

To summarise, on this analysis children fail to evaluate ambiguous utterances successfully because they cannot hold message contents under their particular terms of description. For the same reason, we claim, children should not be able to answer a substitution-sensitive question about what was said. However, they should find it easier to answer a substitution-insensitive question, where reference is not determined by the particular form of the referential term. This is a powerful prediction since there are no other clear a priori reasons for thinking that "The round balloon' is that what I *said*?" or "Did I *say* that it was the round balloon that I chose?" should be hard for children to answer, while "Did I *say* that the red balloon was round?" should be easy.

Furthermore, this analysis predicts that children's ability to trace the source of ambiguity to the message should be related to their ability to handle mentalistic opaque contexts in an adult manner (such as the substitution-sensitive questions of Apperly & Robinson, 1998). Such a finding would support a general account of children's problems in this domain as stemming from a basic problem with handling partial representations, rather than a specific mentalising, linguistic or pragmatic problem.

## 2. Experiment 1

### 2.1. Method

#### 2.1.1. Participants

Forty-eight children (28 boys and 20 girls) aged between 4 years and 2 months and 5 years and 2 months (mean age 4 years and 8 months) who were in reception classes, and forty-nine children (25 boys and 24 girls) between 5 years and 3 months and 6 years 2 months (mean age 5 years and 9 months) from Year 1 classes were tested. We shall refer to these as 4–5- and 5–6-year-olds, respectively. Although at the low end of the age range commonly used for experiments on understanding of ambiguity, these children attended a particularly good primary school with a middle class catchment area in Birmingham, UK, and were of an unusually high general educational standard.

#### 2.1.2. Materials

In the communication game we employed duplicate sets of four picture cards. For warm up trials the pictures were four different coloured cats easily distinguished from each other. For the experimental trials the pictures varied on two dimensions, making it simple to refer to them ambiguously. There were sets of balloons that varied in their colour and shape, and sets of men who varied in the size and colour of their hats. In the partial knowledge tasks we used a bouncy ball contained in a tin box (as described above) and a ruler that was also an eraser, contained in a pencil case. Each item was referred to by two possible descriptions, “ball”/“present” and “ruler”/“rubber” but in each case, only one description was obvious from visual inspection, “ball” and “ruler.” (“Rubber” is the standard British term for an eraser). The protagonist for all conditions was a puppet called Heinz.

#### 2.1.3. Procedure

Children played a communication game similar to that used by Robinson et al. (1983) and also received two partial knowledge tasks like those used by Apperly and Robinson (1998). In the *communication game* the child and puppet protagonist (Heinz) each received identical sets of picture cards depicting different coloured cats. On four short warm up trials the messages from the puppet (relayed by whispering to the experimenter) were always unambiguous (for example “Heinz says he’s chosen the blue cat”) and children were asked to select the picture that he had chosen. Four experimental trials followed, in which the sets of cards varied in two respects, shape and colour. However, within trial, the child and puppet each received only two pictures that varied in one respect only, such as two red balloons,

one round and one long. On each trial the puppet gave an ambiguous message (via the experimenter) such as “Heinz says he chose the red balloon.” Children were usually quick to select one of their cards as “the one Heinz chose,” and each time, the puppet held up the other card that was consistent with the message to show that the child’s choice was incorrect.

On two trials they were then asked about message ambiguity in the same way as in Robinson et al. (1983): “Did Heinz tell us enough?” and if they said “No,” “What should he have told us?” To pass, children had to answer both questions correctly. The other two trials asked about what Heinz had said with a different type of question in each. The substitution-insensitive say question, for example “Did Heinz say that the red balloon was round?” was modelled upon the substitution-insensitive partial knowledge question, “Does Heinz know that the ball is a present?” The substitution-sensitive say question, such as “Did Heinz say it was the round balloon that he chose?” was modelled upon the substitution-sensitive partial knowledge question, “Does Heinz know that there’s a present in the box?” (which is also analogous to Robinson et al.’s “The man with the blue flower, is that what I said?”). Importantly, the word “say” was stressed in these questions, and the puppet’s chosen picture was obscured. Thus, it was pragmatically clear that the question referred to the puppet’s first referential utterance rather than his subsequent act of showing the card that he had chosen. The four trials were presented in semicounter-balanced order, avoiding two consecutive trials involving message evaluation.

On the *partial knowledge tasks*, children were first allowed to look at the stimuli and all children spontaneously identified the items by the visually obvious description and this was repeated by the experimenter. To agree the second label for the ball, children were conspiratorially informed “. . .this is going to be a present for Heinz, except we haven’t told him and we don’t want him to find out right now, so we’ll have to whisper very quietly when he looks.” For the ruler, children were allowed to feel the item in the pencil case. If they did not spontaneously identify it as a rubber it was demonstrated until the description was agreed. The two descriptions were then reiterated, emphasising the different modes of perceptual access “. . .so it looks like a ruler but it feels like a rubber.” Children then observed as Heinz looked inside the box or the pencil case. The lack of other perceptual access was emphasised in the case of the ball by whispering the questions, and in the case of the ruler by saying “Now Heinz is going to look, but he’s not going to feel.”

With the contents now out of sight within their containers, children were asked two questions in counter-balanced order: An substitution-insensitive question “Does Heinz know that the ball is a present?” and a substitution-sensitive (intensional) question, “Does Heinz know there’s a present in the box?” both of which have the correct answer “No.” The pair of trials came together either before or after the ambiguity trials and order of the two trials was counter-balanced between child.



## 2.2. Results

There were no effects of test order (all  $P$ s > .12 by one-way ANOVA) so all orders were combined for further analysis. All 4–5-year-olds answered all the ambiguity questions, so for comparisons within ambiguity tasks,  $N=48$ . On the partial knowledge tasks 10 out of 48 4–5-year-old children failed to complete all the test conditions because they refused to accept that the puppet could see or know anything, thus for these tasks and for comparison between conditions 38 children were included. In the 5–6-year-old sample, 2 out of 49 children failed to complete all of the partial knowledge test conditions for the same reason. Thus,  $N=47$  for any comparisons including these tasks, while for comparisons within ambiguity tasks  $N=49$ .

First we checked that the results with the *partial knowledge tasks* replicated those reported by Apperly and Robinson (1998). Table 1 shows children's performance on the substitution-insensitive and substitution-sensitive questions of the two partial knowledge tasks. Consistent with previous findings both the 4–5- and 5–6-year-olds found the substitution-insensitive questions (“...know the ball is a present”) significantly easier than the substitution-sensitive ones (“...knows there's a present in the box.”) (sign test,  $P < .0001$ , and  $< .0042$ , respectively). There was a significant difference in performance on the substitution-sensitive questions between age groups [ $\chi^2(2, N=85)=6.52, P=.04$ ], which, on inspection of the data, is clearly due to improvement with age. There was no such change in children's performance on the substitution-insensitive questions, which as expected was very good in both age groups.

Next we considered children's performance in the *communication game* (see Table 2). Importantly, there were differences in children's ability to answer the substitution-insensitive question (“...say the red balloon was round?”) and the substitution-sensitive (intensional) question (“...say it was the round balloon he chose?”) and inspection of the data reveals these differences to be in line with our first prediction. In the 4–5 year old group this effect was nonsignificant with

Table 1

Frequency of 4–5- and 5–6-year-olds' correct responses to the substitution-insensitive and substitution-sensitive questions in the partial knowledge tasks of Experiment 1

Number of substitution-sensitive (“...knows there's a present in the box”) questions correct	Number of substitution-insensitive (“...knows the ball is a present”) questions correct							
	4–5-year-olds ( $N=38$ )				5–6-year-olds ( $N=47$ )			
	0	1	2	Total	0	1	2	Total
0	5	5	4	14	2	3	2	7
1	0	4	7	11	0	4	9	13
2	0	0	13	13	1	1	25	27
Total	5	9	24	38	3	8	36	47

Table 2

Frequency of 4–5- and 5–6-year-olds' correct responses to questions in the communication game of Experiment 1

Age group	Number of successful evaluations of message quality: "Did Heinz tell us enough?"; "What should he have said?"			Number correct on substitution-insensitive question ("...say the red balloon was round?")	Number correct on substitution-sensitive question ("...say it was the round balloon he chose?")
	0	1	2		
4–5-year-olds ( <i>N</i> =48)	22 (46%)	6 (12%)	20 (42%)	31 (65%)	25 (52%)
5–6-year-olds ( <i>N</i> =49)	17 (35%)	6 (12%)	26 (53%)	44 (90%)	29 (59%)

seven children succeeding on the substitution-insensitive and not the substitution-sensitive question, and only one showing the opposite pattern ( $P = .07$  by sign test). Fifteen 5–6-year-olds succeeded on the substitution-insensitive and not the substitution-sensitive question and none showed the opposite pattern ( $P < .0001$  by sign test). Recall that we were concerned to make it pragmatically clear that both of these questions referred to Heinz's first referential utterance, rather than his subsequent act of showing the card that he had chosen. The above pattern of good performance on the substitution-insensitive question suggests that our efforts were indeed successful, and therefore that children's failure on the substitution-sensitive question is unlikely to be due to a simple misinterpretation of this kind.

On the message evaluation trials children were asked, "Did he tell us enough?" and if not "What should he have said?" and had to answer both correctly in order to obtain a score of 1. Thus, a maximum score of 2 was available from the two evaluation trials. Between the two age groups there were no significant differences in scores [ $\chi^2(2, N=97) = 1.41, P = .49$ ]. However, it can be seen in Table 2 that the pattern is for improvement with increasing age. Next we looked at the relationship between children's performance on the questions about what was said and their ability to answer the message evaluation questions. Taking first the substitution sensitive question about what was said, for each age group we compared answers to the substitution-sensitive question with those for each of the two message evaluation questions. Our focus was on children who answered only one of the two questions correctly (either the message evaluation question or the substitution sensitive question), to test for a difference in difficulty between the two question types. Amongst the 4–5-year-olds, seven children got the first message evaluation questions correct but the substitution-sensitive question incorrect while four showed the opposite pattern; on the second message evaluation question three children showed the

former pattern of errors, and two showed the latter. Among the 5–6-year-olds, the pattern of such errors was 5:6 and 4:3 for the two message evaluation questions. These differences were all nonsignificant by sign test: all  $P_s > .54$ . These results provide no evidence of a difference in difficulty between the message evaluation question and the substitution sensitive question about what was said.

In contrast, children were significantly better on the substitution-insensitive question in every comparison. Once more, performance on each message evaluation question was compared with performance on the substitution-insensitive question. Among the 4–5-year-olds, seven children were correct on the substitution-insensitive question but not the first message evaluation question while no children showed the opposite pattern. The same comparison with the second message evaluation question showed 9:0 differences,  $P_s = .016$  and  $.004$ , respectively. The 5–6-year-olds showed 14:0 and 16:0 differences in the same direction: both  $P_s < .0001$ . No child passed a message evaluation task without having also passed the substitution-insensitive question about what was said. This appears inconsistent with an account that attributes problems with understanding ambiguity to an inability to hold message meaning separate from intended referent.

There was another important difference in the relationship between children's ability to evaluate message ambiguity and performance on the substitution-insensitive and substitution-sensitive questions, though this emerged only for the older age group. In the 5–6-year-old group, only five children answered the substitution-insensitive question incorrectly and none of these passed either pair of message evaluation questions, yet of those who passed, 12 out of 44 failed both message evaluation tasks and 6 out of 44 failed one. In contrast, these children's success or failure on the substitution-sensitive question showed a strong relationship with their performance on the message evaluation task [ $\chi^2(2, N=49)=21.6, P<.0001$ ], with 14 out of 20 children who answered incorrectly failing both evaluation tasks and 23 out of 29 who answered correctly passing both. In sum, whatever ability was behind children's success on the substitution-insensitive question appeared to be necessary but not sufficient to enable successful evaluation of message quality. In contrast, whatever ability lay behind success on the substitution-sensitive question appeared to be both necessary and sufficient for success at evaluating ambiguous messages. This pattern of relationships did not emerge in the 4–5 year old group, because their success on the easier, substitution-insensitive, question was still far from perfect (see Table 2). In this younger group there was significant contingency between children's performance on both substitution-insensitive and substitution-sensitive questions and their score on the pairs of message evaluation questions [ $\chi^2(2, N=48)=31.1, P<.0001$ ;  $\chi^2(2, N=48)=25.1, P<.0001$ , respectively].

Finally, we looked at the relationship between children's performance on the message evaluation questions in the communication game and the substitution-

sensitive (intensional) questions of the partial knowledge tasks (see Table 3). We carried out a stepwise regression analysis with children's score on the message evaluation question as the dependent variable. In the first and second steps, age (in months) and score on the substitution-insensitive questions of the partial knowledge tasks were entered. Age alone showed little relation with message evaluation ability (adjusted  $R^2 = .004$ ). Addition of performance on the substitution-insensitive questions of the partial knowledge tasks in the second step resulted in a significant change in  $R^2$ :  $F(1,82) = 13.58$ ,  $P < .0001$ . The further addition of performance on the substitution-sensitive question from the partial knowledge tasks in the third step resulted in a significant increase in  $R^2$ :  $F(1,81) = 7.08$ ,  $P = .009$ .

This suggests that a significant proportion of the variation in children's message evaluation ability was accounted for by performance on the substitution-sensitive questions about partial knowledge. This effect was apparent even after variation in more basic mentalising ability (as measured by the substitution-insensitive questions) had been accounted for. When considered together with the corroborating pattern of contingencies within the questions of the communication game, this provides good support for our claim that message evaluation and handling of intensional contexts — as measured by the substitution-sensitive questions in both types of task — make importantly similar demands on children.

Experiment 1 provides promising support for both of our predictions about children's handling of ambiguous utterances. First, the substitution-insensitive question about what was said in the ambiguous utterance was significantly easier than a substitution-sensitive question. Additionally, the substitution-sensitive question was more closely related to children's ability to evaluate message ambiguity than was the substitution-insensitive question. In line with our second prediction, there was a relationship between children's handling of the substitution-sensitive questions about partial knowledge and their handling of linguistic ambiguity, over and above their ability to answer the substitution-insensitive question about partial knowledge. In Experiment 2 we looked again at the relationship between children's handling of partial knowledge and of ambiguity,

Table 3

Number of correct responses to the message evaluation task and substitution-sensitive questions of the partial knowledge task of Experiment 1

Number of message evaluation questions correct	Number of substitution-sensitive questions correct in partial knowledge task			
	0	1	2	Total
0	15	8	9	32
1	2	6	2	10
2	4	10	29	43
Total	21	24	40	85

and used a more powerful design to investigate the relationship between the three types of question about ambiguous messages.

### 3. Experiment 2

Children were again asked message evaluation questions and questions about what was said in substitution-insensitive and substitution-sensitive forms, but this time each child answered two questions of each of the three types so we could use a step-wise regression to examine the relationship between them. We included partial knowledge tasks like those we had used in Experiment 1, but we also broadened the range of this investigation by including story-based tasks like those used by Russell (1987).

#### 3.1. Method

##### 3.1.1. Participants

Fifty-three children were tested. Two were excluded for not accepting that the puppet could see, hear or say anything. Of the remaining 51 children 26 were girls and 25 were boys, aged between 5 years and 2 months and 6 years (mean age 5 years and 8 months). These children attended a good infant/junior school with a middle class catchment area in Birmingham, UK, were of high educational standard and spoke English as their first language.

##### 3.1.2. Materials

In the communication game we used duplicate sets of two picture cards. For warm up trials the pictures were four different coloured cats, easily distinguished from one another. Pictures in the experimental trials differed in two respects, making it simple to refer to them ambiguously. There were sets of balloons and sets of faces that differed in their colour and shape, sets of men whose hats differed in size and colour and sets of balls and cups that also differed in size and colour. Handling of partial knowledge was assessed by the ball/present and ruler/rubber tasks from Experiment 1, and by story-based tasks like those used by Apperly and Robinson (in press) and Russell (1987). One story, about George who does not know that the thief who has stolen his watch has curly red hair, was taken directly from Russell's study; the other, about a girl who does not know that the lady in the blue jumper is her teacher, was used by Apperly and Robinson (in press). The communication game and the object-based partial knowledge tasks used a puppet protagonist called Heinz.

##### 3.1.3. Procedure

The procedure was similar to that used in Experiment 1. In the *communication game* each child received six experimental trials in which the puppet gave an ambiguous message (via the experimenter). In two trials they were asked

message evaluation questions: “Did Heinz tell us enough?” and if they said “No,” “What should he have told us?” Children had to answer both questions correctly to pass. In two trials they were asked the substitution-sensitive question about what Heinz had said (such as “Did Heinz say that it was the round balloon that he chose?”), and in two more they were asked the substitution-insensitive question (such as “Did Heinz say that the red balloon was round?”). Children were given one of each question type (order counterbalanced between child), followed by a trial in which the message was unambiguous and the child could pick the correct picture. The three remaining experimental trials followed, in the same order as the first three.

The *partial knowledge tasks* were presented consecutively either before or after the communication game. Each child received two tasks, one object-based (as in Experiment 1) and one story-based. There were two pairs of object-based and story-based tasks, which were varied between-child.

### 3.2. Results and discussion

Table 4 shows children’s performance on the message evaluation and substitution-sensitive questions about ambiguous messages, and substitution-sensitive questions about partial knowledge.

First we checked that the results from the *partial knowledge tasks* were consistent with previous findings. Children were given two scores out of two, according to their number of correct answers on the substitution-sensitive and substitution-insensitive questions. An ANOVA was computed with these scores as repeated measures, and age category (upper or lower half of the sample) and question order (substitution-sensitive or substitution-insensitive first) as between subject factors. There was a significant main effect of question type,  $F(1,47)=29.0$ ,  $P<.0001$ , with substitution-insensitive questions easier than substitution-sensitive questions. All other effects were nonsignificant (all  $P_s > .113$ ). These results confirm the previous findings that children found it easier to report on another’s partial knowledge when the

Table 4  
Number of correct responses on the message evaluation and substitution-sensitive questions about ambiguous messages, and substitution-sensitive questions about partial knowledge in Experiment 2

Number of message evaluation questions correct	Number of substitution-sensitive questions correct							
	Ambiguous utterance task				Partial knowledge task			
	0	1	2	Total	0	1	2	Total
0	10	1	0	11	6	4	1	11
1	4	1	4	9	2	7	0	9
2	1	4	26	31	3	17	11	31
Total	15	6	30	51	11	28	12	51

question was in the substitution-insensitive form rather than the substitution-sensitive form.

Next we considered children's performance in the *communication game*. Each child was given a score out of two for their performance on the three types of question about ambiguous messages (message evaluation, substitution-insensitive and substitution-sensitive). In one ANOVA we compared performance on the substitution-sensitive and substitution-insensitive question as repeated measures, age category (upper or lower half of the sample) and question order as between subject factors. There was a significant main effect of question type [ $F(1,39) = 11.8, P = .001$ ], and inspection of the means showed that the substitution-sensitive question was harder than the substitution-insensitive question. This is consistent with our predictions and with the findings of Experiment 1. All other effects were nonsignificant (all  $P_s > .21$ ). A second similar ANOVA was computed to compare performance on the substitution-insensitive and message evaluation questions. There was a significant main effect of question type [ $F(1,39) = 4.25, P = .046$ ], with the substitution-insensitive questions easier than the message evaluation questions. There was a significant interaction between question type and age category [ $F(1,39) = 4.52, P = .041$ ], and inspection of the means showed this to be due to the younger children, but not the older children performing better on the substitution-insensitive question than the message evaluation question. This is consistent with the results of Experiment 1. There was also a significant interaction between question type and question order [ $F(1,39) = 2.61, P = .040$ ]. This appeared to be due to anomalously poor performance on the message evaluation question in one of two question orders in which the message evaluation question came first.

The design of Experiment 2 allowed us to make a stronger test of the hypothesis that whatever lies behind children's successful reporting of "what was said" on the substitution-insensitive question was necessary but not sufficient for successful message evaluation, while whatever lies behind success on the substitution-sensitive question was both necessary and sufficient. We carried out a stepwise regression analysis with children's score on the message evaluation question as the dependent variable. In the first and second steps, age (in months) and score on the substitution-insensitive questions were entered. Age alone showed little relation with message evaluation ability (adjusted  $R^2 = .021$ ). Addition of performance on the substitution-insensitive questions resulted in a significant change in  $R^2$  [ $F(1,48) = 35.7, P < .0001$ ], suggesting that performance on these two questions was related. However, the addition of performance on the substitution-sensitive question in the third step resulted in a further significant increase in  $R^2$  [ $F(1,47) = 20.7, P < .0001$ ]. This suggests that the substitution-sensitive questions were not just a harder version of the substitution-insensitive questions, but that the extra problems they posed were shared with the message evaluation task.

In a similar analysis we considered the relationship between performance on the message evaluation questions and the substitution-sensitive and substitution-

insensitive questions of the partial knowledge tasks. Again, children's score on the message evaluation question was entered as the dependent variable in a stepwise regression analysis. In the first and second steps, age (in months) and score on the substitution-insensitive questions of the partial knowledge tasks were entered. This time, addition in the second step of performance on the substitution-insensitive questions of the partial knowledge tasks did not change  $R^2$  significantly [ $F(1,48)=2.51, P=.12$ ], suggesting that performance on these two questions was unrelated. However, the addition of performance on the substitution-sensitive question from the partial knowledge tasks in the third step resulted in a significant increase in  $R^2$  [ $F(1,47)=11.6, P=.001$ ]. This is consistent with our prediction that the substitution-sensitive partial knowledge questions were related to children's ability to evaluate message ambiguity, over and above children's ability to answer substitution-insensitive questions.

#### 4. Final discussion and conclusions

In the introduction we outlined the view that children fail to evaluate ambiguous utterances as such because they do not hold in mind the distinction between what was said and what was meant (Robinson et al., 1983). If this is correct, then once children know the intended referent, they should tend to accept *any* true description of that referent as having been said (Robinson & Whittaker, 1987). A different prediction arises when children's difficulties with ambiguity are described in terms of problems with partial representations (Apperly & Robinson, 1998). If children cannot treat the referential scope of a referring expression as narrowed by its particular terms of description, they should be able to consider the message itself in some circumstances that we can specify.

Our results showed that children's success at considering what was said was indeed sensitive to the phrasing of the question. Substitution-insensitive questions ("Did Heinz say the red balloon was round?") were relatively easy, but children were much less proficient on the substitution-sensitive questions in which the referring expression ("round balloon") also served to ask how the content was described in the ambiguous utterance: "Did Heinz say it was the round balloon that he chose?" Many children who answered the substitution-insensitive questions nevertheless correctly failed to identify the ambiguous messages as inadequate ("Did he tell us enough?", "What should he have said?"), but the substitution-sensitive questions were comparable in difficulty to the message evaluation questions.

As with the mentalistic opaque contexts concerning what Heinz knows, there appears to be a contradiction in children's pattern of responding. On an adult understanding of the verb "say" it is inconsistent to agree that "Heinz said that it was the round balloon he chose" while denying that "Heinz said that the red balloon was round." In the case of handling partial knowledge, we argued that success on the substitution-insensitive question did not indicate mastery: Chil-



dren still made errors not just on the substitution-sensitive question but also at predicting action on the basis of partial knowledge. This finding might caution us against inferring adult competence at understanding message meaning from children's success with the substitution-insensitive question about what was said. Children clearly understand something about message meaning at this point, but we argue that they can succeed on the substitution-insensitive question for the very reason that it *is* insensitive to the terms in which reference is secured to the object it describes. Therefore, like its mentalistic counterpart, it does not tap children's ability to model the partial relationship that exists between an object (in this case the intended referent) and its representation (the message).

Thus, although we argue against trying to dichotomise children who can and children who cannot distinguish message meaning from the referent of the message, the crucial insight behind the account offered by Robinson et al. (1983) is retained in the current description of children's problems with linguistic ambiguity. For if children do not represent a linguistic expression under its particular terms they lack the capacity to reflect on the aspects of meaning arising therefrom. From the child's point of view, an utterance will appear to be adequate so long as it is consistent with the object of reference. So whilst children may be aware that a *unique* referent has not been identified, they will not locate the problem in the utterance itself, since it seems to have done its job quite adequately. Thus, there does indeed remain an important sense in which children are unable to consider the meaning of an utterance apart from its intended meaning.

Before discussing broader implications of this suggestion, we consider whether substitution-insensitive questions (about knowledge or about what was said) are easier than substitution-sensitive questions because they prompt children or make the experimenter's intentions more clear. Two sets of results suggest that this is not the case. First, if the substitution-insensitive question was merely a clearer version, one might expect that success on that would prime a substitution-sensitive question about the very same content. Yet we have found that this is almost never the case (Apperly, 1999; Apperly & Robinson, 1998, in press). This lack of effect is not restricted to substitution-sensitive questions: Success on the substitution-insensitive question does not prime children's ability to predict or explain action on the basis of the same partial knowledge either. Second, in Apperly and Robinson (in press) we tried to use supporting context to eliminate children's problems with substitution-sensitive questions. Six-year-old children observed incorrect action on the basis of partial knowledge, the process of partial knowledge acquisition was discussed using thought bubbles, and a substitution-sensitive question was rhetorically posed and answered (correctly) by one of the story characters just before it was re-posed to the child. Even these interventions failed to eliminate the difference in difficulty between substitution-insensitive and substitution-sensitive questions. To summarise, for adults, knowledge that a person who knows about the X in the box but does not know that the X is a Y, logically entails (1) that the person does not

know that “there is a Y in the box,” and (2) that they will not retrieve the X/Y object if they desire a Y. Young children clearly fail on both (1) and (2), and this effect is robust to manipulations that aim to make the entailment as clear as possible. We see this as adequate justification for concluding that although answers to the substitution-insensitive question may suggest that children can handle partial knowledge successfully, a broader view of their abilities suggests that this is not the case.

We now turn to the larger domain of children’s developing social cognition. Since tasks that require children to handle false beliefs (e.g., Gopnik & Astington, 1988; Wimmer & Perner, 1983) occupy centre stage in this literature, we will begin by examining our findings from this reference point. A number of authors argue for a strong relationship between children’s handling of false belief and referential opacity (e.g., de Villiers & de Villiers, 2000; Gopnik, 1993; Kamawar & Olson, 1999; Leslie, 1987; Mitchell, 1996; Olson & Kamawar, 1999; Perner, 1991). Our data suggest a clear dissociation between these abilities, consistent with the findings of Russell (1987). One explanation for the difference between our conclusion and those of Leslie (1987), Mitchell (1996) and Perner (1991) in particular, concerns the reasons why the test questions used were substitution-sensitive. In our studies (and Russell’s) test questions about Heinz’s knowledge or about what was said were substitution-sensitive because they reported a mental state or an utterance that *partially* represented its referent in a relevant respect. To this extent our questions were consistent with the textbook examples of referential opacity that turn on one person not knowing that terms such as morning star and evening star or Oedipus’ mother and Oedipus’ wife refer to the same object (see e.g., Haack, 1978).<sup>2</sup> In contrast, test questions in false belief tasks are substitution-sensitive because they focus on a mental state that is out of date and so in mismatch with its real referent. As representations, false beliefs are necessarily also partial, but their partial character is never the issue in false belief procedures. In research into children’s developing understanding about the mind the assumption is often made that false belief tasks make the same demands as handling of textbook referential opacity, but this important distinction between the reasons for substitution-sensitivity has not been made.

Another reason why a link between false belief and opacity has been assumed in the literature lies in the theory that credits children who pass false belief tasks with a representational understanding of mind (e.g., Perner, 1991). Accounts of this kind have been very successful at accommodating many developments at around the age of 4. However, understanding representations clearly entails understanding that representations are partial. Our finding that children cannot handle referential opacity for some time after handling false beliefs is clearly indirect evidence against their having such understanding. Direct evidence comes from our finding (Apperly & Robinson, 1998) that children who correctly predict

---

<sup>2</sup> Textbook cases of referential opacity are thus intensional contexts on Searle’s (1983) definition.

the action of a protagonist with a false belief often fail to predict correctly the action of a partially informed person. Thus, we conclude that there are good reasons for resisting the claim that children who pass false belief tasks possess a representational understanding of mind.

Although we did not make direct comparisons, we can also infer from our findings that children who pass false belief tasks are not necessarily able to evaluate ambiguity in messages. This is clearly consistent with the view of Chandler (1988), Carpendale and Chandler (1996) and Sodian (1988) that children's folk psychology undergoes further qualitative change after they succeed on false belief tasks at around 4 years. According to Chandler, children are "copy theorists" about mental states until 6–7 years, when they change to an "interpretive theory." This allows children to understand both the informativeness of an experience and the fact that different people who are equally informed might interpret a particular input — an ambiguous utterance or drawing for example — in different ways. However, any account in terms of changes in children's explicit theoretical knowledge about the mind will find it difficult to accommodate the difference in difficulty between the substitution-insensitive and substitution-sensitive questions about partial knowledge, or the substitution-insensitive question and the ability to predict action on the basis of the same partial knowledge (see Apperly & Robinson, 1998). Our account differs from Chandler's (and from "theory–theory" accounts in general) by pitching the level of explanation somewhat lower: Children's failure to represent the partial nature of representations is not a deficit in explicit, theoretical knowledge about the mind but a problem with the requirement to represent content under multiple descriptions simultaneously.<sup>3</sup> We argue that understanding the substitution-sensitive question requires its representational content to be held as partial, while the substitution-insensitive question does not. At this lower level of description the discrepancy between performance on substitution-insensitive and substitution-sensitive questions is not a sign of rational inconsistency within a particular theory, but rather a product of the limits on the way in which meaning is processed at different points in development.

### **Acknowledgments**

The first experiment reported was carried out in partial fulfilment of the degree of PhD for the first author, who was supported by a studentship from the Biotechnology and Biological Sciences Research Council, UK. The second

---

<sup>3</sup> Clearly this is also a problem posed by both the false belief and deceptive box tasks, and also by nonmentalistic out of date and counterfactual situations (to name just two). However, while the formal problem may be similar, we have argued (Apperly and Robinson, 1998) that these different situations — which involve holding content under multiple descriptions — could plausibly vary in difficulty for children.

experiment was carried out with financial support from the Economic and Social Research Council, UK grant number R000237932.

## References

- Apperly, I. A. (1999). Children's mental representation of referential relations: representational partitioning and "theory of mind." Unpublished PhD thesis, University of Birmingham, Birmingham, UK.
- Apperly, I. A., & Robinson, E. J. (1998). Children's mental representation of referential relations. *Cognition*, *63*, 287–309.
- Apperly, I. A., & Robinson, E. J. (in press). Children's difficulty handling of dual identity. *Journal of Experimental Child Psychology*.
- Beal, C. R. (1988). Children's knowledge about representations of intended meaning. In: J. W. Astington, P. L. Harris, & D. R. Olson (Eds.), *Developing theories of mind* (pp 315–325). Cambridge: Cambridge Univ. Press.
- Beal, C. R., & Flavell, J. H. (1982). Effect of increasing the salience of message ambiguities on kindergarteners' evaluations of communicative success and message adequacy. *Developmental Psychology*, *18*, 43–48.
- Bonitatibus, G. (1988). What is said and what is meant in referential communication. In: J. W. Astington, P. L. Harris, & D. R. Olson (Eds.), *Developing theories of mind* (pp 326–341). Cambridge: Cambridge Univ. Press.
- Carpendale, J., & Chandler, M. (1996). On the distinction between false belief understanding and subscribing to as interpretive theory of the mind. *Child Development*, *67*, 1686–1706.
- Chandler, M. (1988). Doubt and developing theories of mind. In: J. W. Astington, P. L. Harris, & D. R. Olson (Eds.), *Developing theories of mind* (1st ed., pp. 387–414). Cambridge: Cambridge Univ. Press.
- de Villiers, J., & de Villiers, P. (2000). Linguistic determinism and the understanding of false beliefs. In: K. Riggs, & P. Mitchell (Eds.), *Children's reasoning and the mind* (pp. 191–228). Hove, UK: Psychology Press.
- Flavell, J. H., Speer, J. R., Green, F. L., & August, D. L. (1981). The development of comprehension monitoring and knowledge about communication. *Monographs of the Society for Research in Child Development* (Serial number 192).
- Gopnik, A. (1993). How we know our minds: the illusion of first-person knowledge of intentionality. *Behavioural and Brain Sciences*, *16*, 1–14.
- Gopnik, A., & Astington, J. W. (1988). The development of children's understanding of representational change. In: J. W. Astington, P. L. Harris, & D. R. Olson (Eds.), *Developing theories of mind* (1st ed., pp. 193–206). Cambridge: Cambridge Univ. Press.
- Haack, S. (1978). *Philosophy of logics*. Cambridge: CUP.
- Kamawar, D., & Olson, D. R. (1999). Children's representational theory of language: the problem of opaque contexts. *Cognitive Development*, *14*, 531–548.
- Leslie, A. M. (1987). Pretence and representation: the origins of "Theory of mind". *Psychological Review*, *94*, 412–426.
- Mitchell, P. (1996). *Acquiring a conception of mind*. Psychology Press.
- Olson, D. R., & Kamawar, D. (1999). The theory of ascriptions. In: P. D. Zelazo, J. W. Astington, & D. R. Olson (Eds.), (Ed.), *Developing theories of intention: social understanding and self-control* (pp. 153–166). Mahwah, NJ: Lawrence Erlbaum Associates.
- Perner, J. (1991). *Understanding the representational mind* (1st ed.). Cambridge, MA: MIT Press: A Bradford Book.
- Robinson, E. J. (1994). What people say, what they think and what is really the case: children's understanding of utterances as sources of knowledge. In: P. Mitchell, & C. Lewis (Eds.),

- Children's early understanding of mind: origins and development* (1st ed., pp. 355–381). Hove, UK: Lawrence Erlbaum.
- Robinson, E. J., Goelman, H., & Olson, D. R. (1983). Children's understanding of the relation between expressions (what is said) and intentions (what was meant). *British Journal of Developmental Psychology*, 1, 75–86.
- Robinson, E. J., & Robinson, W. P. (1977). Development in the understanding of causes of success and failure in verbal communication. *Cognition*, 5, 363–378.
- Robinson, E. J., & Robinson, W. P. (1983). Children's uncertainty about the interpretation of ambiguous messages. *Journal of Experimental Child Psychology*, 36, 81–96.
- Robinson, E. J., & Whittaker, S. J. (1985). Children's responses to ambiguous messages and their understanding of ambiguity. *Developmental Psychology*, 21, 446–454.
- Robinson, E. J., & Whittaker, S. J. (1986). Children's conceptions of meaning–message relationships. *Cognition*, 22, 41–60.
- Robinson, E. J., & Whittaker, S. J. (1987). Children's conceptions of relations between messages, meanings and reality. *British Journal of Developmental Psychology*, 5, 81–90.
- Russell, J. (1987). “Can we say...?” children's understanding of intentionality. *Cognition*, 25, 289–308.
- Russell, J. (1996). *Agency its role in mental development* (1st ed.). UK: Erlbaum.
- Searle, J. (1983). *Intentionality, vol. 1* (1st ed.). Cambridge: Cambridge Univ. Press.
- Sodian, B. (1988). Children's attributions of knowledge to a listener in a referential communication task. *Child Development*, 59, 703–718.
- Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, 13, 103–128.